

STARS

University of Central Florida
STARS


UCF Forum

6-8-2016

How Did We Wind Up in Such an Unlikely Universe?

Michael Bass

University of Central Florida

 Part of the [Communication Commons](#), [Life Sciences Commons](#), [Physical Sciences and Mathematics Commons](#), and the [Science and Mathematics Education Commons](#)

Find similar works at: <https://stars.library.ucf.edu/ucf-forum>

Information presented on this website is considered public information (unless otherwise noted) and may be distributed or copied. Use of appropriate byline/photo/image credit is requested. We recommend that UCF data be acquired directly from a UCF server and not through other sources that may change the data in some way. While UCF makes every effort to provide accurate and complete information, various data such as names, telephone numbers, etc. may change prior to updating.

STARS Citation

Bass, Michael (2016). How did we wind up in such an unlikely universe?. UCF Today, 2016-06-08.
Retrieved from <https://today.ucf.edu/undefined-56/>

This Opinion column is brought to you for free and open access by STARS. It has been accepted for inclusion in UCF Forum by an authorized administrator of STARS. For more information, please contact STARS@ucf.edu.





How Did We Wind Up in Such an Unlikely Universe?

By Michael Bass
UCF Forum columnist
Wednesday, June 8, 2016

Not long ago the Public Broadcasting Service program NOVA presented an episode called “The Great Math Mystery.” It dealt with the many ways mathematical relationships and special numbers crop up when investigating the physical and natural world.

Physicists have developed the Standard Model to describe everything we know about the universe from quantum mechanics dealing with the incredibly small subatomic world, to gravity and cosmology that deal with the universe on the very large scale.

The Standard Model is amazingly accurate when explaining and predicting observed phenomena. It contains theories that are incredibly accurate when predicting the observed behaviors of quarks, atoms, light sources, cannon balls, planets, stars, galaxies and the beginning of the universe as we observe them, only if certain numbers are exactly what they are measured to be.

If these numbers are not what they are, the model doesn’t work.

Perhaps another model is needed – however, if the numbers are not what they are, stars don’t exist the way they must to cook up the elements that are necessary to produce such strange beings as us. We are a part of the universe that is around to ask what had to happen to enable us to exist.

To answer such a question we first have to ask how the universe came into existence and how did it develop into what we see around us today. All the evidence from our astronomy and astrophysics points to a universe that was born about 13.8 billion years ago from a quantum fluctuation of incredibly hot energy and grew into everything in less

than a second. In the three minutes that followed, atoms of hydrogen, deuterium, helium and a little bit of lithium were formed as the universe cooled.

That's all the atoms that were formed in the beginning. Clearly there were not all of the atoms needed to produce us. There was no carbon, no oxygen, no calcium and no iron, to name a few essentials to life as we know it. So what had to happen next?

Time had to pass and the universe had to cool off some more.

When it did, gravity could take effect in places when the gas density was a little higher than elsewhere and pull surrounding gas into a collapsing ball. As it collapsed it got hot enough so that nuclear fusion started. The first stars were born.

When the first stars died they seeded the galaxies in which they existed with lots of higher atomic number atoms that had been cooked up through nuclear fusion. These atoms became part of the next generations of stars and so in the third generation of star formation, the sun, a very ordinary main sequence star, was born about 4.5 billion years ago, in a very ordinary spiral galaxy.

The material left over around the sun also contained these atoms so when some of it coalesced into planets, they contained these atoms.

On the third planet out from the sun these atoms formed molecules that became complex as time went by. After about 1 billion years, with the help of energy radiated from the sun and generated by fusion reactions in the planet's core, there were molecules that could form copies of themselves – and biology started.

Today the earth has lots of biology on it, including us thinking about how all this could come about.

For all the steps described above to have happened as outlined, such numbers as the gravitational constant, the charge on the electron, the mass of the electron, the difference between the proton and neutron masses, the density of mass in the universe, the mass of the neutrino, Planck's constant, and the speed of light must be what we have measured them to be. For them all to be what they are by random chance is the very unlikely probability of 1 part in 10^{234} . You certainly would not bet on these odds.

So how did we wind up in such an unlikely universe?

Some of those who believe in God say that God set these numbers at the beginning so that the universe would develop to allow His creations to exist. This is a way in which believers in an all-powerful god can connect their beliefs with the facts of science.

Others who consider the Bible literally true have more difficulty making the connection. They might argue that an all-powerful god can do anything he wanted to do and set the numbers at whatever values he wished at any time he wished. A god with that degree of capriciousness could have made the numbers that we measure different at different times.

Those who hold the belief that God can set the numbers at any value he wishes will continue to hold that belief claiming that the scientific test was incomplete or incorrect. Others will see that science and their beliefs are compatible. The inherent difference between science and religion-belief will continue to be misunderstood by the large majority of people. To put it most simply science deals with what can be proven wrong, and religion deals with what can not.

Some physicists claim there is a multiverse, an infinity of universes, and we are in one that has the right numbers for us to exist. Other physicists studying string theory claim the extra dimensions necessary for string theory to be consistent are rolled up in ways that determine the numbers.

It turns out that the number of ways of rolling up these extra dimensions can be very large, approaching infinity. Once again we are looking at ours being one of an infinity of universes.

In an infinity of universes there can be an infinity of universes having exactly the set of numbers that are needed to produce a universe such as ours.

As a consequence, our universe may not be as unique as we think.

Then again, except in science fiction stories, it is the only universe we will ever have, so let's get used to it.

We should continue to study it, to try to understand it and to marvel at its beauty.

Michael Bass is a professor emeritus of optics at CREOL (Center for Research and Education in Optics and Lasers) in UCF's College of Optics & Photonics. He can be reached at bass@creol.ucf.edu.

